Appendix H
Potential R&PP Locations Identified

Potential R&PP Locations Identified

T. 24 N., R. 9 W.
Sec. 25

T. 25 N., R. 11 W.
Sec. 18

T. 27 N., R. 11 W.
Sec. 35

T. 28 N., R. 11 W.
Sec. 10 & 15

T. 29 N., R. 10 W.
Sec. 17 & 18

T. 29 N., R. 11 W.
Sec. 3, 10, 29 & 31

T. 29 N., R. 12 W.
Sec. 2, 10, 11, 17, 18, 33 & 34

T. 30 N., R. 9 W.
Sec. 27 & 28

T. 30 N., R. 10 W.
Sec. 17 & 18

T. 30 N., R. 11 W.
Sec. 2, 3, 5, 6, 7, 10, 11, 14, 15, 17, 20, 21, 23, 26, 27 & 28

T. 30 N., R. 12 W.
Sec. 1, 2, 11, 12 & 20

T. 30 N., R. 13 W.
Sec. 26, 27 & 34

T. 30 N., R. 14 W.
Sec. 26 & 34

T. 30 N., R. 14 W.
Sec. 31

T. 31 N., R. 8 W.
Sec. 3, 4, 9 & 10

T. 31 N., R. 11 W.
Sec. 31, 32, 33 & 34

T. 31 N., R. 12 W.
Sec. 4, 5, 9,10 & 34

T. 32 N., R. 6 W.
Sec. 7 & 8

T. 32 N., R. 7 W.
Sec. 13

T. 32 N., R. 8 W.
Sec. 33 & 34

T. 32 N., R. 10 W.
Sec. 21

T. 32 N., R. 13 W.
Sec. 10, 15 & 22

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Appendix I
OHV Management

Implementing Area Designations and Guidance for Site-Specific Planning

Introduction

Background

The off-highway portion of the Draft EIS for the FFO is a programmatic planning document and is intended to provide the environmental analysis and disclosure needed to amend OHV area designations in the proposed resource management plan.

The Draft EIS addresses the impacts of motorized wheeled OHV travel on areas currently available to cross-country travel. The proposed decision would amend the resource management plan OHV designations on approximately 1.4 million acres of public land within the FFO. This designation limits/restricts motorized wheeled cross-country travel yearlong under BLM regulations (CFR 8342). The proposed action does not change the current limited/restricted yearlong or closed designations, or designated OHV intensive use areas within the existing Special Management Areas. Site specific planning would address OHV use in each OHV Management Unit.

The programmatic Draft EIS is not intended to change existing site-specific direction to close areas or trails to the traffic types causing considerable adverse effects (43 CFR 8341.2). Identifying affected areas or trails may occur through normal administration and monitoring or may be the result of public input.

Planning Process

EIS/Plan Amendment: Planning for BLM lands involves two levels of decision. The first level, often referred to as programmatic planning, is the development or amendment of the resource management plan, which provides management direction for the various resource programs, uses, and protection measures. The resource management plan and associated amendments are intended to set out management prescriptions with goals, objectives, standards, guidelines, and terms and conditions for future decision-making through site-specific planning. This includes the designation of areas as closed, open, or restricted/limited to motorized wheeled cross-country travel.

Site-Specific Planning: The second level of planning involves the analysis and implementation of management practices designed to achieve goals and objectives of the resource management plan. This is referred to, as project, activity, or site-specific planning that requires detailed information, including the location, condition, and current use of individual roads, trails, routes, and areas. This allows the identification of when and where individual roads, trails, routes and areas will be open or closed to various types of use. This step is accomplished through the site-specific planning process at the local level, and is dependent on the availability of funds and resources. A prioritized list of areas for site-specific planning would be completed within six months after the signing of the Record of Decision for the Final EIS.

This would be consistent with the land use planning manual and handbook (Manual 1600 and Handbook H-1600-1) and any future OHV planning policy.

Prioritization for Site Specific Planning

Introduction

To ensure that site-specific planning is initiated in areas of the most need, areas would be identified by three categories to provide appropriate emphasis for their completion. Prioritization for site-specific planning would be done by OHV management unit or by SMA and would be rated as high, moderate, or low based on several factors.

Prioritization of Areas

The FFO would complete a prioritized list of areas for site-specific planning within six months of the signing of the ROD in close coordination with the public.

Factors: When determining the priorities for site-specific planning, the FFO will consider the effects of the Final EIS; Executive Orders 11644 and 11989; the National Management Strategy for Motorized Off-Highway Vehicle Use on Public Lands; coordination with the public; other partners, agencies, and tribal governments; and the factors listed below:

- Opportunity to provide a variety of OHV recreational experiences, while minimizing resource damage and conflicts.
- Risk of, or current damage to, soil watersheds, vegetation, or other natural, cultural or historic resources on public land.
- Potential to spread noxious weeds.
- Avoidance of riparian/wetland areas.
- Need to minimize harassment of wildlife or significant degradation of wildlife habitats.
- Concern for safety of all users.
- Resolution of conflicts between various user groups.
- Current or potential impacts to federally listed threatened or endangered, and sensitive species.
- Amount of public land within the disposal zone.

Categories: OHV management units and applicable SMAs will be included in one of the following categories:

HIGH PRIORITY AREAS – Areas that currently have a high level of OHV use, which has resulted in resource damage and/or user conflicts. There is the need to address all or most of the factors listed above. Site-specific planning would be initiated within two years of the resolution of any protests to the Final EIS or administrative appeals to the ROD.

MODERATE PRIORITY AREA – These areas may address some of the factors listed above, as well as identifying areas that provide OHV opportunities, and at the same time minimize user conflicts and resource damage. Site-specific planning would be started within five years (same guidelines as above).

LOW PRIORITY AREAS – Areas where the majority of the public land is in the disposal zone and/or there is low OHV use due to remoteness and distance from the major population centers. Any resource problems can be solved with emergency closures until they are resolved. There are no specific requirements for initiation of site-specific planning.

Road/Trail/Route/Area Inventory

Through site-specific planning, roads, routes, trails, and areas would be inventoried, mapped and designated as open, limited by season or type of vehicle, or closed.

Site-specific planning would identify appropriate locations and types of allowable use based on resource management plan desired conditions and management conditions. In addition, site-specific planning may identify areas for trail construction and/or improvement, or specific areas where intensive OHV use may be appropriate. Integration of other resource objectives and other types of recreational use would be incorporated at this time.

User Needs

Site-specific planning would identify issues needing resolution at the site-specific level. The following procedure would be followed:

1. Define the scope of the analysis. The boundaries of the area to be analyzed would be the prioritized OHV Management Unit and/or the Special Management Area.

2. Identify and describe vehicle travel needs for individual roads, routes, trails and areas. Consider the reasons for needing access to the area, what travel mode is needed or desired, and why people choose to participate in a specific activity in a particular place. Is access needed for:

    - Meeting recreation opportunities and demand?
    - Commodity production?
    - Water production?
    - Special use permits?
    - Rights-of-way, legal access, easements, cost-share or prescriptive rights?
    - Private in holdings?
    - Hazardous waste remediation or watershed restoration?
    - Fire protection or law enforcement?
    - Barrier-free recreation opportunities or special access accommodations as needed by individuals?
    - Other access needs?

3. Identify and describe needs and/or reasons to limit travel in the OHV Management Unit. Consider the potential effects of different uses on:

    - Wildlife habitat
    - Grazing allotments
    - Soils
    - Water quality
    - Riparian areas
    - Threatened and endangered species habitat
    - Cultural resources
    - Native vegetation
    - Conflicting uses
    - Public safety
    - Special management areas
    - Lessees and permittees
    - Other access restriction needs

Development of Alternatives

Alternatives should reflect a range of distribution strategies for agency and public land users. The distribution strategies must balance requirements for restrictions with the needs for vehicle travel. They must also address the objectives for the area. Planning prescriptions should be developed for roads, routes, trails, and areas within the analysis area.

Decision

Completion of site-specific planning for an area will establish a permanent management plan for that particular area through the designation of roads, routes, trails, and areas open, limited, or closed for a particular use.

Bibliography of Environmental and Social Effects of OHVs

Overviews

Andrews, R.N.L. and P.E. Nowak. 1980. *Off-Road Vehicle Use: A Management Challenge.* Ann Arbor, MI: University of Michigan Extension Service.

Baldwin, M. 1973. *The Off-Road Vehicle and Environmental Quality*. Washington D.C.: The Conservation Foundation.

Belknap, L.K. 1986. "Off-Highway Motorcycles." Pp. Activities 19-29, in *A Literature Review: The President's Commission of Americans Outdoors*. Washington, D.C.: U.S. Government Printing Office.

Bleich, J.L. 1988. "Chrome on the Range: Off-Road Vehicles on Public Lands*." Ecology Law Review.* Volume 15, Pp. 159-187.

College of Natural Resources. 2002. *Off-Road Vehicle Management Practices Manual.* Burlington, VT: University of Vermont.

Lodico, N.J. 1973. *The Environmental Effects of Off-Road Vehicles: A Review of the Literature.* Washington D.C.: U.S. Department of the Interior, Office of Library Services, Research Services Branch.

Petulla, J.M. 1977. "The Impact of ORVs." Pp. 377-378, in: *American Environmental History.* San Francisco, CA: Boyd and Fraser.

Sheridan D. 1979. *Off- Road Vehicles on Public Land.* Washington, D.C.: Council on Environmental Quality.

Stokowski, P.A. and C.B. LaPointe, *2000 Environmental and Social Effects of ATVs and ORVs: An Annotated Bibliography and Research Assessment.* Burlington, VT: School of Natural Resources, University of Vermont.

U.S. Department of the Interior. 2001. *National Management Strategy for Motorized Off-Highway Vehicle Use on Public Lands*. Washington D.C.: Bureau of Land Management.

Vancini, F.W. 1989. *Policy and Management Considerations for Off-Road Vehicles: Environmental and Social Impacts.* Ithaca, N.Y.: Cornell University.

Wildlife

Brattstrom, B.H. and M.C. Bondello. 1983. "Effects of Off-Road Vehicle Noise on Desert Vertebrates." Pp 167-206, in R.H. Webb and H.G. Wilshire (eds.): *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*. New York, NY: Springer-Verlag.

Bury, R.B., R.A. Luckenbach, and S.O. Busack. 1977. *Effects of Off-Road Vehicles on Vertebrates in the California Desert*. Wildlife Research Report 8:1-23. Washington D.C.: U.S. Fish and Wildlife Service.

Bury, R.B. 1980. "What We Know and Do Not Know about Off-Road Vehicle Impacts on Wildlife." Pp. 110-122, in R.N.L. Andrews and P.F. Nowak (eds.): *Off-Road Vehicle Use: A Management Challenge*. Conf. Proc. 16-18. March. Ann Arbor, MI.

Busack, S.D. and R.B. Bury. 1974. "Some Effects of Off-Road Vehicles and Sheep Grazing on Lizard Populations in the Mojave Desert." *Biological Conservation*. Volume 6, Number 3, Pp. 179-183.

Cole, D.N. and P.B. Landres. 1995. "Indirect Effects of Recreation on Wildlife." Pp. 183-202, in R.L. Knight and K.J. Gutzwiller (eds.): *Wildlife and Recreationists: Coexistence through Management and Research*. Washington D.C.: Island Press.

Gabrielsen, G.W. and E.N. Smith. 1995. "Physiological Responses of Wildlife to Disturbance." Pp. 95-107, in R.L. Knight and K.J. Gutzwiller (eds.): *Wildlife and Recreationists: Coexistence through Management and Research*. Washington D.C.: Island Press.

Yarmoloy, C., M. Bayer, and V. Geist. 1988. "Behavior Responses and Reproduction of Mule Deer, *Odocoileus hemionus*, Does Following Experimental Harassment with an All-Terrain Vehicle." *Canadian Field Naturalist*. Volume 102, Pp. 425-429.

Vegetation

Lathrop, E.W. 1983. "The Effect of Vehicle Use on Desert Vegetation." Pp. 154-166, in R.H. Webb and H.G. Wilshire (eds.): *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*. New York, NY: Springer-Verlag.

Payne, G.G., J.W. Foster, and W.C. Leininger.1983. "Vehicle Impacts on Northern Great Plains Range Vegetation." *Journal of Range Management*. Volume 36, Pp. 327-331.

Weaver, T., and D. Dale. 1978. "Trampling Effects of Hikers, Motorcycles, and Horses in Meadows and Forests." *Journal of Applied Ecology*. Volume 15, Number 2, Pp. 451-457.

Soils

Eckert, Jr., R.E., M.K. Wood, W.H. Blackburn, and F.F. Peterson. 1979. "Impacts of Off-Road Vehicles on Infiltration and Sediment Production of Two Desert Soils." *Journal of Range Management*. Volume 32, Number 5, Pp. 394-397. September.

Gillette, D.A. and J. Adams. 1983. "Accelerated Wind Erosion and Prediction of Rates." Pp. 97-109, in R.H. Webb and H.G. Wilshire (eds.): *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*. New York, NY: Springer-Verlag.

Webb, R.H. 1983. "Compaction of Desert Soils by Off-Road Vehicles." Pp. 51-79, in R.H. Webb and H.G. Wilshire (eds.): *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*. New York, NY: Springer-Verlag.

Microbiotic Crusts

Belnap, J. 1994. "Potential Role of Cryptobiotic Soil Crust in Semiarid Rangelands." Pp. 179-185, in S.B. Monsen and S.G. Kitchen (eds.): *Proceedings: Ecology and Management of Annual Rangelands*. General Technical Report INT-GTR-313. USDA Forest Service, Intermountain Research Station. Ogden, UT.

Belnap, J. 1995. "Surface Disturbances: Their Role in Accelerating Desertification." *Environmental Monitoring and Assessment*. Volume 37, Pp. 39-57.

Evans, R.D., and J. Belnap. 1999. "Long-Term Consequences of Disturbances on Nitrogen-Cycling in an Arid Grassland." *Ecology*. Volume 80, Pp. 150-160.

U.S. Department of Agriculture. 1997. *Introduction to Microbiotic Crusts.* Natural Resources Conservation Service: Soil Quality Institute.

Recreational Conflict

Badaracco, R.J. 1976. "ORVs: Often Rough on Visitors." *Parks and Recreation*. Volume 11, Number 9, Pp. 32-35.

Jacob, G.R. and R. Schreyer. 1980. "Conflict in Outdoor Recreation: A Theoretical Perspective." *Journal of Leisure Research*. Volume 12, Number 4, Pp. 368-375.

Jackson, E.L. and R.A.G. Wong. 1982. "Perceived Conflict between Urban Cross-Country Skiers and Snowmobilers in Alberta." *Journal of Leisure Research*. Volume 14, Number 1, Pp. 47-62.

Kockelman, W.J. 1983. "Management Concepts." Pp. 399-446, in R.H. Webb and H.G. Wilshire (eds.): *Environmental Effects of Off-Road Vehicles: Impacts and Management in Arid Regions*. New York, NY: Springer-Verlag.

Lindsay, J.J. and C.P. Cialdi. 1978. *Vermont Trail Bike Study*. University of Vermont, School of Natural Resources. Recreation Management Program, Research Report SNR-RM5.

Malone, R. 1981. "ORVs: Kicking Up Dust." *American Forests*. Volume 87, Number 11, Pp. 61-63.

Noe, F.P., J.D. Wellman, and G. Buhyoff. 1982. "Perception of Conflict between Off-Road Vehicle and Non-Off-Road Vehicle Users in a Leisure Setting." *Journal of Environmental Systems*. Volume 11, Pp. 223-233.

Schneider, I. and W. Hammitt. 1995. "Visitor Response to Outdoor Recreation Conflict: A Conceptual Approach." *Leisure Sciences*. Volume 17, Number 3, p. 223.

Watson, A.E. 1995. "An Analysis of Recent Progress in Recreation Conflict Research and Perceptions of Future Challenges and Opportunities." *Leisure Sciences*. Volume 17, Number 3, p. 235.

Appendix J
Air Quality Data

Table J-1. Annual Gas Production Data and Emissions for the BLM Farmington/Rio Puerco RMPs—Alternative A

Project Year	Wells in Production[1]	Annual Production (Bscf)[2]	Tons per Year			
			VOC	CO	NOx	PM_{10}
1	221	23.4	51	1,195	1,225	1
2	442	46.8	102	2,390	2,451	1
3	663	70.1	153	3,584	3,676	2
4	884	93.5	204	4,779	4,901	2
5	1,105	116.9	254	5,974	6,127	3
6	1,326	140.3	305	7,169	7,352	3
7	1,547	163.7	356	8,363	8,578	4
8	1,768	187.0	407	9,558	9,803	4
9	1,989	210.4	458	10,753	11,028	5
10	2,210	233.8	509	11,948	12,254	5
11	2,431	257.2	560	13,143	13,479	6
12	2,652	280.6	611	14,337	14,704	6
13	2,873	304.0	662	15,532	15,930	7
14	3,094	327.3	712	16,727	17,155	7
15	3,315	350.7	763	17,922	18,381	8
16	3,536	374.1	814	19,116	19,606	8
17	3,757	397.5	865	20,311	20,831	9
18	3,978	420.9	916	21,506	22,057	9
19	4,199	444.2	967	22,701	23,282	10
20	4,420	467.6	1,018	23,896	24,507	10
Totals	46,410	4,910				

Notes: (1) Assumes an annual growth rate of $1/20^{th}$ of the total wells assumed for the alternative, or 4,420 wells/20 years = 221 wells per year and all wells stay in production once developed.

(2) Annual production = wells in production per year * annual well production.
Annual well production = total production for the alternative/total well-years, or 4,910 billion standard cubic feet (Bscf)/46,410 well-years = 0.106 Bscf/well-year.

Table J-2. Emission Factors for Sources Associated with the BLM Farmington/Rio Puerco RMPs

Equipment Type	Emission Factor (Grams/Hp-Hr)				Source
	VOC	CO	NOx	PM_{10}	
Wellhead Compressor	0.30	13.05	13.15	0.0001	(1)
Separator Unit	5.50	40.00	94.00	7.60	(2)
Central Compressor	0.47	1.29	1.64	0.0001	(3)

Notes: (1) VOC data for a Caterpillar G3304 unit (Kaufman 2001). CO and NOx data from source test survey of units from 65-145 Hp (AQB 2001a). PM_{10} data from AP-42 (EPA 2000), Section 3.2, Table 3.2.2.

(2) AP-42 Section 1.4, residential furnaces. Units in pounds per million cubic feet of gas.

(3) VOC data for a Caterpillar G3312 unit (Caterpillar Inc., 2001). CO and NOx data from source test survey of units from 2,500-4,500 Hp (AQB 2001a). PM_{10} data from AP-42 (EPA 2000), Section 3.2, Table 3.2.2.

Table J-3. Operational Data for Emission Sources Associated with the BLM Farmington/Rio Puerco RMPs—Alternative A

Scenario/Equipment Type	Horse-power	Load Factor	Hourly Hp-Hr	Annual Hp-Hr	Hourly Fuel Use (scf)	Annual Fuel Use (Mscf)
Average Producing Well						
Wellhead Compressor - Cat G3304[1]	95	0.43	40	353,685	341	2.99
Separator Unit[2]	250,000	0.25	62,500	N/A	69	0.60
Annual Central Compression Needs						
Central Compressor - Cat 3612[3]	6,040	0.90	5,436	47,619,360	40,605	355.70

Notes: (1) Wellhead compressors expected at 50% of the proposed wells and would operate at 100% load and 85% of the year. Therefore, the annualized load factor per well is 42.5%. Gas heating values = 905 BTUs.

(2) Separator units expected at 50% of proposed wells and would operate at 100% load and 50% of the year. Therefore, the annualized load factor per well is 25%. Horsepower = unit firing rate of 250,000 BTUs/Hr and Hourly Hp-Hr = hourly firing rate of 62,500 BTUs/Hr.

(3) Central compression would reach 120,800 Hp by the end of the 20-year project period. Implementation assumed to be at a rate of 120,800 Hp/20 years = 6,040 Hp/year. The annualized load factor is 90%.

Table J-4. First Year Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative A

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	25.8	1,124.4	1,133.0	0.0
Separator Units	0.4	2.7	6.3	0.5
Central Compression	24.7	67.7	86.1	0.0
Alternative A - Tons per Year	**50.9**	**1,194.8**	**1,225.4**	**0.5**
P&A Wells - Tons per Year	**(8.3)**	**(340.9)**	**(344.9)**	**(0.2)**
Alternative A Net Change (Alt A - P&A)	**42.6**	**853.8**	**880.5**	**0.4**

Table J-5. Year 20 Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative A

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	517.0	22,487.8	22,660.1	0.2
Separator Units	7.4	53.5	125.7	10.2
Central Compression	493.4	1,354.3	1,721.7	0.1
Alternative A - Tons per Year	**1,017.7**	**23,895.5**	**24,507.5**	**10.4**
P&A Wells - Tons per Year	**(273.7)**	**(11,273.8)**	**(11,404.7)**	**(5.1)**
Alternative A Net Change (Alt A - P&A)	**744.1**	**12,621.7**	**13,102.7**	**5.3**

Table J-6. Reduction of Annual Production and Emissions for the BLM Farmington/Rio Puerco RMPs—P&A Wells

Project Year	New Wells P&Aed[1]	Cumulative Wells P&Aed[1]	Annual Production Loss (Bscf)[2]	Tons per Year			
				VOC	CO	NOx	PM_{10}
1	133	133	3.7	8	341	345	0
2	140	273	7.6	17	699	707	0
3	147	419	11.7	26	1,075	1,087	0
4	154	573	16.1	36	1,470	1,487	1
5	162	735	20.6	46	1,884	1,906	1
6	170	905	25.3	56	2,319	2,346	1
7	178	1,083	30.3	67	2,776	2,808	1
8	187	1,270	35.6	79	3,256	3,294	1
9	197	1,467	41.1	91	3,759	3,803	2
10	206	1,673	46.8	104	4,288	4,338	2
11	217	1,890	52.9	118	4,844	4,900	2
12	227	2,117	59.3	132	5,427	5,490	2
13	239	2,356	66.0	147	6,039	6,109	3
14	251	2,607	73.0	162	6,682	6,760	3
15	263	2,870	80.4	179	7,357	7,443	3
16	276	3,146	88.1	196	8,066	8,160	4
17	290	3,437	96.2	214	8,810	8,913	4
18	305	3,742	104.8	233	9,592	9,703	4
19	320	4,062	113.7	253	10,412	10,533	5
20	336	4,398	123.1	274	11,274	11,405	5
Totals	**4,398**	**39,153**	**1,096**				

Notes: (1) Assumes an annual growth rate of 5%.

(2) Annual production loss = wells in production per year * annual well production. Annual well production = total production for the alternative/total well-years, or 11,158 Bscf/139,556 well-years = 0.07995 Bscf/well-year.

Table J-7. Operational Data for Emission Sources Associated with P&A Wells—BLM Farmington/Rio Puerco RMPs

Scenario/Equipment Type	Horse-power	Load Factor	Hourly Hp-Hr	Annual Hp-Hr	Hourly Fuel Use (scf)	Annual Fuel Use (Mscf)
Average Producing Well						
Wellhead Compressor - Cat G3304[1]	95	0.21	20	177,259	171	1.50
Separator Unit[2]	250,000	0.13	31,250	N/A	35	0.30
Annual Central Compression Needs						
Central Compressor - Cat 3612[3]	0.68	0.90	1	5,361	5	0

Notes: (1) Wellhead compressors expected at 25% of the proposed wells and would operate at 100% load and 85% of the year. Therefore, the annualized load factor per well is 21.3%. Gas heating values = 905 BTUs.

(2) Separator units assumed at 25% of P&A wells and would operate at 100% load and 50% of the year. Therefore, the annualized load factor/well is 12.5%. Horsepower = unit firing rate of 250,000 BTU/Hr and Hourly Hp-Hr = hourly firing rate of 62,500 BTUs/Hr.

(3) Represents central compression associated with one P&A well-year.

Table J-8. First Year Annual Emissions Associated with P&A Wells—BLM Farmington/Rio Puerco RMPs

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	7.8	339.1	341.7	0.0
Separator Units	0.1	0.8	1.9	0.2
Central Compression	0.4	1.0	1.3	0.0
P&A Wells - Tons per Year	**8.3**	**340.9**	**344.9**	**0.2**

Table J-9. Year 20 Annual Emissions Associated with P&A Wells—BLM Farmington/Rio Puerco RMPs

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	257.8	11,213.7	11,299.6	0.1
Separator Units	3.7	26.6	62.5	5.1
Central Compression	12.2	33.5	42.6	0.0
P&A Wells - Tons per Year	**273.7**	**11,273.8**	**11,404.7**	**5.1**

Table J-10. Annual Gas Production Data and Emissions for the BLM Farmington/Rio Puerco RMPs—Alternative B

Project Year	Wells in Production[1]	Annual Production (Bscf)[2]	Tons per Year			
			VOC	CO	NOx	PM_{10}
1	664	53.1	152	3,587	3,678	2
2	1,328	106.3	305	7,174	7,357	3
3	1,991	159.4	457	10,760	11,035	5
4	2,655	212.5	609	14,347	14,713	6
5	3,319	265.7	761	17,934	18,391	8
6	3,983	318.8	914	21,521	22,070	9
7	4,646	371.9	1,066	25,108	25,748	11
8	5,310	425.1	1,218	28,694	29,426	13
9	5,974	478.2	1,370	32,281	33,104	14
10	6,638	531.3	1,523	35,868	36,783	16
11	7,301	584.5	1,675	39,455	40,461	17
12	7,965	637.6	1,827	43,042	44,139	19
13	8,629	690.7	1,979	46,628	47,818	20
14	9,293	743.9	2,132	50,215	51,496	22
15	9,956	797.0	2,284	53,802	55,174	24
16	10,620	850.1	2,436	57,389	58,852	25
17	11,284	903.3	2,588	60,976	62,531	27
18	11,948	956.4	2,741	64,562	66,209	28
19	12,611	1,009.5	2,893	68,149	69,887	30
20	13,275	1,062.7	3,045	71,736	73,565	31
Totals	**139,388**	**11,158**				

Notes: (1) Assumes an annual growth rate of 1/20th of the total wells assumed for the alternative, or 13,275 wells/20 years = 664 wells per year and all wells stay in production once developed.

(2) Annual production = wells in production per year * annual well production. Annual well production = total production for the alternative/total well-years, or 11,158 Bscf/139,388 well-years = 0.08 Bscf/well-year.

Table J-11. Operational Data for Emission Sources Associated with the BLM Farmington/Rio Puerco RMPs—Alternative B

Scenario/Equipment Type	Horse-power	Load Factor	Hourly Hp-Hr	Annual Hp-Hr	Hourly Fuel Use (scf)	Annual Fuel Use (Mscf)
Average Producing Well						
Wellhead Compressor - Cat G3304[1]	95	0.43	40	353,685	341	2.99
Separator Unit[2]	250,000	0.25	62,500	N/A	69	0.60
Annual Central Compression Needs						
Central Compressor - Cat 3612[3]	18,000	0.90	16,200	141,912,000	121,008	1,060

Notes: (1) Wellhead compressors expected at 50% of the proposed wells and would operate at 100% load and 85% of the year. Therefore, the annualized load factor per well is 42.5%. Gas heating values = 905 BTUs.

(2) Separator units expected at 50% of proposed wells and would operate at 100% load and 50% of the year. Therefore, the annualized load factor per well is 25%. Horsepower = unit firing rate of 250,000 BTU/Hr and Hourly Hp-Hr = hourly firing rate of 62,500 BTUs/Hr.

(3) Central compression would reach 360,000 Hp by the end of the 20-year project period. Implementation assumed to be at a rate of 360,000 Hp/20 years = 18,000 Hp/year. The annualized load factor is 90%.

Table J-12. First Year Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative B

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	77.6	3,377.0	3,402.9	0.0
Separator Units	1.1	8.0	18.9	1.5
Central Compression	73.5	201.8	256.5	0.0
Alternative B - Tons per Year	**152.3**	**3,586.8**	**3,678.3**	**1.6**
P&A Wells - Tons per Year	**(8.3)**	**(340.9)**	**(344.9)**	**(0.2)**
Alternative B Net Change (Alt B - P&A)	**144.0**	**3,245.9**	**3,333.4**	**1.4**

Table J-13. Year 20 Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative B

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM^{10}
Wellhead Compressors	1,552.6	67,539.6	68,057.2	0.5
Separator Units	22.1	160.6	377.5	30.5
Central Compression	1,470.4	4,035.9	5,130.9	0.3
Alternative B - Tons per Year	**3,045.1**	**71,736.1**	**73,565.5**	**31.3**
P&A Wells - Tons per Year	**(273.7)**	**(11,273.8)**	**(11,404.7)**	**(5.1)**
Alternative B Net Change (Alt B - P&A)	**2,771.5**	**60,462.3**	**62,160.7**	**26.2**

Table J-14. Annual Gas Production Data and Emissions for the BLM Farmington/Rio Puerco RMPs—Alternative C

Project Year	Wells in Production[1]	Annual Production (Bscf)[2]	Tons per Year			
			VOC	CO	NOx	PM_{10}
1	492	52.4	113	2,658	2,726	1
2	984	104.8	226	5,316	5,451	2
3	1,475	157.2	339	7,973	8,177	3
4	1,967	209.6	451	10,631	10,902	5
5	2,459	262.0	564	13,289	13,628	6
6	2,951	314.3	677	15,947	16,353	7
7	3,443	366.7	790	18,604	19,079	8
8	3,934	419.1	903	21,262	21,805	9
9	4,426	471.5	1,016	23,920	24,530	10
10	4,918	523.9	1,129	26,578	27,256	12
11	5,410	576.3	1,242	29,235	29,981	13
12	5,902	628.7	1,354	31,893	32,707	14
13	6,393	681.1	1,467	34,551	35,432	15
14	6,885	733.5	1,580	37,209	38,158	16
15	7,377	785.9	1,693	39,866	40,884	17
16	7,869	838.2	1,806	42,524	43,609	19
17	8,361	890.6	1,919	45,182	46,335	20
18	8,852	943.0	2,032	47,840	49,060	21
19	9,344	995.4	2,144	50,497	51,786	22
20	9,836	1,047.8	2,257	53,155	54,511	23
Totals	**103,278**	**11,002**				

Notes: (1) Assumes an annual growth rate of 1/20th of the total wells assumed for the alternative, or 13,275 wells/20 years = 664 wells per year and all wells stay in production once developed.

(2) Annual production = wells in production per year * annual well production. Annual well production = total production for the alternative/total well-years, or 11,158 Bscf/139,388 well-years = 0.08 Bscf/well-year.

Table J-15. Operational Data for Emission Sources Associated with the BLM Farmington/Rio Puerco RMPs—Alternative C

Scenario/Equipment Type	Horse-power	Load Factor	Hourly Hp-Hr	Annual Hp-Hr	Hourly Fuel Use (scf)	Annual Fuel Use (Mscf)
Average Producing Well						
Wellhead Compressor - Cat G3304[1]	95	0.43	40	353,685	341	2.99
Separator Unit[2]	250,000	0.25	62,500	N/A	69	0.60
Annual Central Compression Needs						
Central Compressor - Cat 3612[3]	13,350	0.90	12,015	105,251,400	89,747	786

Notes: (1) Wellhead compressors expected at 50% of the proposed wells and would operate at 100% load and 85% of the year. Therefore, the annualized load factor per well is 42.5%. Gas heating values = 905 BTUs.

(2) Separator units expected at 50% of proposed wells and would operate at 100% load and 50% of the year. Therefore, the annualized load factor per well is 25%. Horsepower = unit firing rate of 250,000 BTU/Hr and Hourly Hp-Hr = hourly firing rate of 62,500 BTUs/Hr.

(3) Central compression would reach 267,000 Hp by the end of the 20-year project period. Implementation assumed to be at a rate of 267,000 Hp/20 years = 13,350 Hp/year. The annualized load factor is 90%.

Table J-16. First Year Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative C

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	57.5	2,502.1	2,521.3	0.0
Separator Units	0.8	6.0	14.0	1.1
Central Compression	54.5	149.7	190.3	0.0
Alternative C - Tons per Year	**112.9**	**2,657.8**	**2,725.6**	**1.2**
P&A Wells - Tons per Year	**(8.3)**	**(340.9)**	**(344.9)**	**(0.2)**
Alternative C Net Change (Alt C - P&A)	**104.6**	**2,316.8**	**2,380.7**	**1.0**

Table J-17. Year 20 Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative C

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM^{10}
Wellhead Compressors	1,150.4	50,042.9	50,426.4	0.4
Separator Units	16.4	119.0	279.7	22.6
Central Compression	1,090.6	2,993.3	3,805.4	0.2
Alternative C - Tons per Year	**2,257.3**	**53,155.2**	**54,511.4**	**23.2**
P&A Wells - Tons per Year	**(273.7)**	**(11,273.8)**	**(11,404.7)**	**(5.1)**
Alternative C Net Change (Alt C - P&A)	**1,983.7**	**41,881.4**	**43,106.7**	**18.1**

Table J-18. Annual Gas Production Data and Emissions for the BLM Farmington/Rio Puerco RMPs—Alternative D

Project Year	Wells in Production[1]	Annual Production (Bscf)[2]	Tons per Year			
			VOC	CO	NOx	PM_{10}
1	497	53.0	114	2,686	2,755	1
2	994	106.0	228	5,373	5,510	2
3	1,491	158.9	342	8,059	8,265	4
4	1,988	211.9	456	10,746	11,020	5
5	2,486	264.9	571	13,432	13,775	6
6	2,983	317.9	685	16,119	16,530	7
7	3,480	370.8	799	18,805	19,285	8
8	3,977	423.8	913	21,492	22,040	9
9	4,474	476.8	1,027	24,178	24,795	11
10	4,971	529.8	1,141	26,865	27,550	12
11	5,468	582.7	1,255	29,551	30,305	13
12	5,965	635.7	1,369	32,238	33,060	14
13	6,462	688.7	1,483	34,924	35,815	15
14	6,959	741.7	1,598	37,611	38,570	16
15	7,457	794.6	1,712	40,297	41,325	18
16	7,954	847.6	1,826	42,984	44,081	19
17	8,451	900.6	1,940	45,670	46,836	20
18	8,948	953.6	2,054	48,356	49,591	21
19	9,445	1,006.5	2,168	51,043	52,346	22
20	9,942	1,059.5	2,282	53,729	55,101	23
Totals	**104,391**	**11,125**				

Notes: (1) Assumes an annual growth rate of 1/20th of the total wells assumed for the alternative, or 13,275 wells/20 years = 664 wells per year and all wells stay in production once developed.

(2) Annual production = wells in production per year * annual well production. Annual well production = total production for the alternative/total well-years, or 11,158 Bscf/139,388 well-years = 0.08 Bscf/well-year.

Table J-19. Operational Data for Emission Sources Associated with the BLM Farmington/Rio Puerco RMPs—Alternative D

Scenario/Equipment Type	Horse-power	Load Factor	Hourly Hp-Hr	Annual Hp-Hr	Hourly Fuel Use (scf)	Annual Fuel Use (Mscf)
Average Producing Well						
Wellhead Compressor - Cat G3304[1]	95	0.43	40	353,685	341	2.99
Separator Unit[2]	250,000	0.25	62,500	N/A	69	0.60
Annual Central Compression Needs						
Central Compressor - Cat 3612[3]	13,500	0.90	12,150	106,434,000	90,756	795

Notes: (1) Wellhead compressors expected at 50% of the proposed wells and would operate at 100% load and 85% of the year. Therefore, the annualized load factor per well is 42.5%. Gas heating values = 905 BTUs.

(2) Separator units expected at 50% of proposed wells and would operate at 100% load and 50% of the year. Therefore, the annualized load factor per well is 25%. Horsepower = unit firing rate of 250,000 BTU/Hr and Hourly Hp-Hr = hourly firing rate of 62,500 BTUs/Hr.

(3) Central compression would reach 270,000 Hp by the end of the 20-year project period. Implementation assumed to be at a rate of 270,000 Hp/20 years = 13,500 Hp/year. The annualized load factor is 90%.

Table J-20. First Year Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative D

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM_{10}
Wellhead Compressors	58.1	2,529.1	2,548.5	0.0
Separator Units	0.8	6.0	14.1	1.1
Central Compression	55.1	151.3	192.4	0.0
Alternative D - Tons per Year	**114.1**	**2,686.5**	**2,755.0**	**1.2**
P&A Wells - Tons per Year	**(8.3)**	**(340.9)**	**(344.9)**	**(0.2)**
Alternative D Net Change (Alt D - P&A)	**105.8**	**2,345.5**	**2,410.1**	**1.0**

Table J-21. Year 20 Annual Emissions Associated with the BLM Farmington/Rio Puerco RMPs—Alternative D

Equipment Type	Tons per Year			
	VOC	CO	NOx	PM^{10}
Wellhead Compressors	1,162.8	50,582.2	50,969.8	0.4
Separator Units	16.5	120.3	282.7	22.9
Central Compression	1,102.8	3,026.9	3,848.1	0.2
Alternative D - Tons per Year	**2,282.2**	**53,729.4**	**55,100.7**	**23.5**
P&A Wells - Tons per Year	**(273.7)**	**(11,273.8)**	**(11,404.7)**	**(5.1)**
Alternative D Net Change (Alt D – P&A)	**2,008.5**	**42,455.6**	**43,695.9**	**18.3**

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Appendix K
Summary of Major Federal, State, and County Authorizing Actions

ACTS OF AUTHORITY AND MANDATES

A series of statutes establish and define the authority of the Secretary of the Interior to make decisions regarding fluid minerals leasing and development. The major relevant statutes are briefly described below.

Table K-1. Major Federal, State, and County Authorizing Actions

Agency and Permit/Approval	Nature of Action	Authority	Application
BLM			
Decision Record for proposed action	Evaluate environmental impacts of proposed action	National Environmental Policy Act (NEPA)	Proposed Federal Action
Permit to Drill	Provide for compliance with regulations and requirements during drilling and completion phases of the well	Mineral Leasing Act of 1920; Federal Oil and Gas Royalty Management Act of 1982; Secretarial Order No. 3087; Amendment No. 1, February 7, 1983; Regulatory controls under 43 Code of Federal Regulations (CFR) 3160	Proposed injection wells and oil and gas wells
Rights-of-way	Grant right-of-way and potentially evaluate the environmental impacts of proposed action	NEPA, Federal Land Policy and Management Act (FLPMA), Mineral Leasing Action of 1920	Pipeline, electrical lines, access roads
Notice of Intent to conduct geophysical exploration	Protect resource values during geophysical exploration activities	FLPMA, Mineral Leasing Act of 1920	Proposed action
Approval to dispose of produced water	Controls disposal of produced water from Federal leases	Mineral Leasing Act of 1920, Regulatory controls under 43 CFR 3160	Well
Permit to use earthen pit (part of Application for Permit to Drill)	Regulates reserve pits on drilling location	Mineral Leasing Act of 1920, Regulatory controls under 43 CFR 3160	Well
Authorization for flaring and venting of gas	Regulates flaring and venting of gas	Mineral Leasing Act of 1920, Regulatory controls under 43 CFR 3160	Well testing and Evaluation
Temporary abandonment of a well	Regulates temporary abandonment of wells	Mineral Leasing Act of 1920, Regulatory controls under 43 CFR 3160	Successful well
Plugging and abandonment of a well	Establishes procedures for permanent abandonment	Mineral Leasing Act of 1920, Regulatory controls under 43 CFR 3160	Dry hole

Agency and Permit/Approval	Nature of Action	Authority	Application
U.S. Army Corps of Engineers			
Section 404 permit	Issue a permit for placement of fill or dredge materials in waters of the United States or adjacent wetlands	Section 404, Clean Water Act (CWA)	Pipeline, road, proposed actions in waters of the United States
U.S. Fish and Wildlife Service			
Consultation process, threatened or endangered species	Review potential impacts on Federally listed and candidate threatened and endangered species	Section 7 of the Endangered Species Act	Federal action
U.S. Environmental Protection Agency			
(Administered by New Mexico Water Quality Control Commission) Stormwater discharge permits (National Pollutant Discharge Elimination System permits)	Regulate discharge to surface waters from point sources	Federal Water Pollution Control Act Amendments and Section 404(p) of CWA	Construction activities disturbing one or more acres
Permit for approval to dispose produced water (also must be approved by the surface management agency)	Issue permit to allow underground injection of produced water	Federal Safe Drinking Water Act, 40 CFR Parts 144 and 147	Underground injection control
(Administered by the Oil Conservation Division of the New Mexico Energy and Minerals Department) Underground Injection Control permit	Ensure potable aquifers are not adversely affected by injection of produced water	Federal Safe Drinking Water Act Underground Injection Control program (40 CFR Parts 144 and 146.22 and 40 CFR Parts 100 to 149, July 1, 1991 revision), Onshore Order No. 7	New injection well
Spill prevention, control, and countermeasure plan	Pollution control	40 CFR Part 112	Drilling operations
New Mexico State Historic Preservation Officer			
Cultural resource Clearance	Review and consultation	Historic Preservation Act of 1966, State Cultural Properties Act of 1977	All proposed action components
New Mexico State Engineer Office			
Permit to appropriate groundwater within declared groundwater basins; approval to use surface water rights	Regulate groundwater use, permit for water wells; regulate surface water use, surface water right	New Mexico Oil and Gas Act, Water Quality Act, NM State Constitution (surface water rights)	All well development

Agency and Permit/Approval	Nature of Action	Authority	Application
New Mexico Energy, Minerals, and Natural Resources Department – Oil Conservation Division			
Permit to drill, re-enter, deepen, plugback, or add a zone (Form C-101)	Permit new wells	New Mexico Oil and Gas Act	New well development
Request for allowable and authorization to transport oil and natural gas (Form C-104)	Permit new wells	New Mexico Oil and Gas Act	New well development
Spill report	Notification of fire, breaks, leaks, spills, and blowouts	OCD Rule 116	In the event of fire, breaks, leaks, spills, and blowouts at drilling operations
New Mexico Environment Department – Air Quality Bureau			
Air emission permits	Permit new sources	Clean Air Act	Combustion sources, compressors, volatile chemical handling, storage piles, and storage tanks

Source: BLM 2000.

REFERENCES

BLM 2000 Bureau of Land Management. 2000. *Draft RMPA/EIS for Federal Fluid Minerals Leasing and Development in Sierra and Otero Counties*. Las Cruces Field Office. Las Cruces, New Mexico. October.

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Appendix L
A Broad Comparison of Coalbed Methane Operations in the San Juan Basin and Powder River Basin

A BROAD COMPARISON OF COALBED METHANE OPERATIONS IN THE SAN JUAN BASIN AND POWDER RIVER BASIN

The following discussion is an overview of coalbed methane (CBM) operations in the San Juan basin of northwestern New Mexico and the Powder River basin of central Wyoming. It includes a brief description of how CBM is formed and provides the basis examining why production operations may vary from play to play.

The production of CBM gas varies according to the physical nature of the gas reservoir and its hydrogeologic setting. CBM is a natural gas that is generated during the conversion of plant materials to coal and is associated with coal beds. It is formed as plant material accumulated in swamps and bogs was subsequently buried in an anoxic environment. The plant material was initially converted to peat as a result of increasing heat and pressure, then to higher grades of coal such as lignite, subbituminous and bituminous coal, and finally, to anthracite. This process is called coalification. Geologic conditions determine the quality of coal that is formed. Thermogenic methane is formed when the temperature in the coalbed exceeds that in which bacteria can live. Secondary, biogenic gas is that gas that is generated by microbes at the coal cleat-water interface. CBM can be adsorbed on the coal, absorbed within the micropores of the coal, stored as free gas in natural fractures called cleats, or contained within water occupying the cleats as solution gas. As coalification takes place, volatile hydrocarbons (usually ethane), carbon dioxide, nitrogen, and water are accumulated. Some gas may escape to the surface or migrate into adjacent rock reservoirs. CBM consists of more than 98 percent methane.

CBM production depends upon the degree of water saturation in the coal cleats and the formation pressure. Considerable CBM is absorbed to the surfaces of the coal matrix and is not free to migrate until water pressure is relieved by lowering the hydrostatic head. Coal that is gas-saturated yields gas upon initial production. Coal that is water-saturated must be depressurized, or dewatered, to facilitate gas desorption. Initial production from water-saturated reservoirs consists of water and little commercial gas (Ayers 2002). Over time, volumes of water produced from a wellbore typically decrease, and CBM production increases as coalbeds near the wellbore are dewatered (USGS 2000).

FRUITLAND FORMATION IN THE SAN JUAN BASIN

Coalbed gas in the San Juan Basin is produced from the Cretaceous Fruitland formation. Production of CBM from the Fruitland coalbeds began in the late 1980s. As of 2000, more than 80 percent of the CBM production in the United States originated from the San Juan basin. The Fruitland coalbeds formed in coastal plain settings and consist of many interfingering deposits. The coalbeds exhibit a net thickness of 50 to 70 feet. A typical wellbore may encounter 6 to 12 coalbeds with a maximum thickness of 20 to 30 feet for any particular coalbed (Ayers 2002).

Studies conducted in the late 1980s determined that coalbed gas occurrence could be defined as three distinct trends, each exhibiting different gas compositions and production characteristics. Trend 1, in the northeastern part of the basin, is named the "fairway" and is the most productive trend. Trend 2 extends from the central part of the basin to its western edge, and Trend 3 includes the eastern and southern part of the basin. Trend 1 is an overpressured area containing thermogenic CBM and up to 30 percent secondary biogenic gas. Trends 2 and 3 result from coalbeds that are less thermally mature and exhibit a lower gas content. Trend 3 is characterized by low permeability coal and limited coalbed gas production.

Groundwater recharge occurs at the northern edge of the San Juan basin. Trend 1 water is characterized by sodium bicarbonate and low chlorides. Total dissolved solids range from moderately to high values. Both chlorides and total dissolved solids (TDS) increase in waters contained in the coalbeds of Trend 3. A hydrochemical boundary occurs at the boundary of the overpressured Trend 1 and underpressured Trends 2 and 3. Waters in Trends 2 and 3 are high chloride waters. The amount of water produced in association with coalbed gas is greatest with fairway wells. In 1992, the average amount of water produced with a CBM well in the northern part of the basin was approximately 250 barrels of water daily. Average daily water production decreases toward the south (Ayers 2002).

There are approximately 3,100 Fruitland wells, 600 of which are in the fairway. Fruitland wells are drilled on 320-acre spacing to an average depth of 2,600 feet. Fruitland coalbed wells in the fairway are usually completed as open-hole cavities at depths that range from 750 to 3,600 feet and produce up to 6 million cubic feet (MMcf) gas per day. Permeability in the Fruitland is facilitated by two face-cleat systems and is highest in the fairway. Fracture stimulation with water may be required to enhance producibility. Parts of the basin in Trends 2 and 3 may require fracture simulation through a cased wellbore. These wells produce from 50 to 500 thousand cubic feet (Mcf) gas per day (Ayers 2002). A few horizontal wells have been drilled in the Fruitland; however, the incremental amount of production did not offset the increased cost of drilling and completion (Palmer et al. 1993).

FORT UNION FORMATION IN THE POWDER RIVER BASIN

Coalbed gas in the Powder River basin is produced from the Tertiary Fort Union formation. Although some CBM drilling in the Powder River basin was initiated in the late 1980s, it was in the late 1990s that the potential of the Fort Union CBM play was recognized. The Powder River basin is currently the most active area of CBM drilling in the United States. These coalbeds are shallow (less than 3,000 feet) and thermally immature (subbituminous coal). The net thickness of the coalbeds ranges from 50 to greater than 215 feet. The center of the basin is overpressured because of greater adsorbed gas content. There are two depositional theories that describe the formation of the Fort Union coalbeds; however, both models reflect thick, extensive coal beds that split and pinch out from the basin center.

The Fort Union contains an abundance of low concentrations of biogenic methane and is considered a major aquifer. Groundwater recharge occurs primarily along the eastern outcrop of the formation. Biogenic methane and carbon dioxide are generated by microbes within the dynamic formation water. When water is produced in association with CBM production, it can sometimes be disposed of into surface drainages, streams, or ponds for beneficial use (Ayers 2002). Water quality is considered good. TDS levels for water released on the surface for beneficial uses range from 1,000 to 2,000 milligrams per liter (mg/L) (USGS 2000).

Although very thick, the low gas content, low pressure, high permeability coals of the Powder River were not at first thought to be good candidates for CBM development. The Powder River basin currently contains approximately 8,167 CBM wells, with 3,655 wells being drilled in 2001 (Ayers 2002). Fort Union wells are drilled on 80-acre spacing. Most wells are less than 750 feet deep. In the Powder River basin, operators have learned to complete shallow wells, pump large quantities of water to move low-pressure gas at a low cost. Some operators are examining the possibility of drilling horizontal wells although the shallow total vertical well depth would make drilling and production difficult (Lang 2000). Fort Union coalbeds are usually produced through open hole completions in a single thick coal seam. Light water fracture stimulation is sometimes required to facilitate production. Average gas production of the wells ranges from 130 to 350 Mcf gas per day after the well has been depressurized for several months. The average amount of water

produced from a typical CBM well ranges from approximately 200 barrels to 500 barrels of water daily. Deeper wells in the more central part of the basin may produce greater than 1,000 barrels of water per day. Average daily water production decreases toward the southern part of the basin (Ayers 2002). The average economic life of a Fort Union CBM well is approximately seven years.

COMPARISIONS BETWEEN FRUITLAND AND FORT UNION CBM PRODUCTION

Operators have discovered that rules of thumb determined while drilling for CBM in the San Juan basin cannot be universally applied to other CBM reservoirs. According to reservoir engineers who work with CBM, "The one thing coalbed methane plays in the US have in common is that they are all different. You have to consider the complete package of coal characteristics, regional geology, and infrastructure" (Lang 2000). Analyzing geologic and hydrogeologic controls along with appropriate production techniques define the key elements of CBM occurrence and producibility. Structural and depositional history determines the thermal maturation of a coalbed, cleat characteristics, and hydrology. The degree of thermal maturation corresponds to the CBM saturation in the coalbed. Cleat characteristics determine the degree of permeability. Hydrological constraints determine the amount and the chemical composition of the subsurface water contained in the coalbed formations (Avery 2002).

Horizontal drilling and completion techniques may be more successful when accessing a single extensive coalbed rather than accessing multiple vertical layers of coalbeds. Although horizontal drilling has been economically prohibitive in the San Juan basin, it may be a feasible technology to employ in the Powder River basin.

Dewatering the coal seam to release and produce CBM through the wellbore has also been known to release methane to the surface in areas where the coalbed is located relatively near the surface (Merschat 1999). Shallow coalbeds are more likely to vent methane to the surface as the coalbeds are dewatered. The average depth of a Fruitland coalbed is much deeper the average depth of a Powder River coalbed; however, gas seepage has been noted in both the Powder River basin and the rim of the San Juan basin near Fruitland coals outcrop. Gas seepage can result in dead vegetation, an increase in the methane content of surface soils, and an apparent increase in the occurrence of methane in domestic water wells (BLM 1999). Dewatering the producing formation can also result in the lowering of the water table, adversely impacting water production from water wells producing from the Fort Union formation.

CBM wells producing from the Fruitland formation in the San Juan basin produce, in general, less water than the average amount of water produced in association with CBM in the Powder River basin. Because the water in the Powder River basin is potable (less than 500 mg/L TDS), a large portion of CBM-produced water could be stored or released on the surface.

Although research is being performed to investigate remediation of San Juan basin CBM-produced water for beneficial use, the high-TDS water produced in the San Juan basin will continue to be injected into deep subsurface formations until an alternative disposal technology is substantiated.

CBM-produced water is not typically reinjected into the producing formation to enhance recovery through fracture stimulation (USGS 2000).

REFERENCES

Ayers 2002 — Ayers, Walter B. 2002. "Coalbed Gas Systems, Resources, and Production, and a Review of Contrasting Cases from the San Juan and Powder River Basins." *AAPG Bulletin*. Volume 86, Number 11. November.

BLM 1999 — Bureau of Land Management. 1999. *Coalbed Methane Development in the Northern San Juan Basin of Colorado: A Brief History and Environmental Observations—A Working Document*.

Lang 2000 — Lang, Karl/IRI Fuels Information Services. 2000. "New Opportunities in Coalbed Methane for Independent Producers." http://www.pttc.org/news/v6n2nn7.htm. Second Quarter.

Merschat 1999 — Merschat, W.R. 1999. "Perspective." *Casper Star-Tribune*. August 29.

Palmer et al. 1993 — Palmer, J.D., S.W. Lambert, and J.L. Spitler. 1993. "Coalbed Methane Well Completions and Stimulations." In B.E. Law and D.D. Rice (eds.): *Hydrocarbons from Coal: AAPG Studies in Geology*.

USGS 2000 — U.S. Geological Survey. 2000. "Water Produced with Coal-Bed Methane." USGS Fact Sheet FS-156-00. November.

Appendix M
Summary of Section 7 Consultation for Threatened/Endangered/Proposed Species

SUMMARY OF SECTION 7 CONSULTATION FOR THREATENED/ENDANGERED/PROPOSED SPECIES

Section 7 (a) (2.) of the Endangered Species Act requires that Federal agencies proposing any activities which may affect Federal listed Threatened or Endangered species consult with the U.S. Fish and Wildlife Service to ensure that they are not likely to jeopardize the existence of listed species or adversely modify designated critical habitat. As part of the consultation process, a biological assessment (BA) was prepared to determine potential effects of activities proposed in the Draft Farmington Resource Management Plan (DRMP) on listed species and critical habitat. The following summarizes the consultation process and provides key excerpts from the BA prepared for the DRMP. The full document contains 109 pages, excluding maps, and is on file at the FFO.

CONSULTATION HISTORY

The Farmington Field Office sent a letter to the U.S. Fish and Wildlife Service on April 25, 2001, requesting a list of Federal Threatened, Endangered, or Proposed species for the project area. A response was received on May 30, 2001 (Cons. #2-22-01-I-389). A draft Biological Assessment was prepared and sent to USFWS for preliminary review. A coordination meeting between the USFWS Albuquerque Field Office and BLM Farmington Field Office staffs was held on July 30, 2002, to discuss the species present in the area and how they might be affected by the actions proposed in the DRMP. The Final BA was delivered to USFWS on September 24, 2002. On October 2, 2002, the USFWS sent a memorandum confirming their concurrence with the effects determinations contained in the BA and concluding Section 7 consultation.

BIOLOGICAL ASSESSMENT EXCERPTS

Eight federally listed and one proposed species are known to occur or have the potential to occur within the planning area (**Table M-1**). In addition, designated critical habitat for the Mexican spotted owl (*Strix occidentalis lucida*) occurs on FFO land. Critical habitat for the Colorado pikeminnow includes part of the San Juan River and the 100-year floodplain from the State Highway 371 Bridge in Farmington down to Lake Powell. This includes all FFO river tracts along the San Juan River between West Farmington and the border of The Navajo Nation. All nine species and the critical habitat will be assessed for the FFO land. Fewer species will be assessed on other federal land because fewer species occur or have the potential to occur on these lands. No designated critical habitat exists outside of the FFO area. The effects of oil and gas development are analyzed for the Knowlton's cactus (*Pediocactus* knowltonii) and bald eagle (*Haliaeetus lecocephalus*) on USBR land, and the mountain plover (*Charadrius montanus*) and southwestern willow flycatcher on AFO land.

Biological Evaluations (BEs), prepared for the grazing allotments on FFO land (BLM 1999a,b,c,d; 2000b; 2001a), addressed BLM's grazing program and evaluated its potential impacts on federally listed and proposed species and critical habitat. It was determined that grazing in six allotments bordering Navajo Reservoir may affect, but is not likely to adversely affect, wintering bald eagles in five allotments, Colorado pikeminnow in one allotment, and Knowlton's cactus in one allotment. It was determined that grazing in these allotments would have no effect on the remaining species. USFWS concurred with these determinations (BLM 1999a) (Cons. #2-22-99-1-419). The BE determined that on 16 riparian grazing allotments along intermittent and ephemeral drainages, and on 117 upland allotments, grazing may affect, but is not likely to adversely affect, the Colorado pikeminnow and razorback sucker, and have no effect on the remaining species (BLM 1999b), to

which the USFWS concurred (Cons. #2-22-99-1-419A). On seven upland allotments, the BE determined that grazing may affect, but is not likely to adversely affect, the Colorado pikeminnow and razorback sucker in all seven allotments, the bald eagle in one allotment, the southwestern willow flycatcher in two allotments, the Mancos milkvetch in one allotment, and the Mesa Verde cactus in three allotments (BLM 1999c). It was determined that grazing would have no effect on the remaining species, with concurrence from the USFWS (Cons. #2-22-99-1-419B). On six allotments in riverine riparian habitat, the BE found that the BLM grazing program may affect, but is not likely to adversely affect, the bald eagle, southwestern willow flycatcher, Colorado pikeminnow, and razorback sucker, and would have no effect on the remaining species (BLM 1999d). The USFWS concurred with these determinations (Cons. #2-22-99-1-419C). In 18 upland allotments containing potential mountain plover habitat, it was determined that the BLM's grazing program may affect, but is not likely to adversely affect, the mountain plover and would have no effect on the other species (BLM 2000b), to which the USFWS concurred (Cons. #2-22-99-1-419D).

Table M-1. Effects Determination for Federally Listed and Proposed Species and Critical Habitat Known to Occur or Potentially Occurring within the Planning Area

Species/Critical Habitat		Status[a]	Effects Determination
Common name	Scientific name		
Knowlton's cactus	*Pediocactus knowltonii*	E	May affect-not likely to adversely affect
Mesa Verde cactus	*Sclerocactus mesae-verdae*	T	May affect-not likely to adversely affect
Mancos milkvetch	*Astragalus humillimus*	E	May affect-not likely to adversely affect
Colorado pikeminnow	*Ptychocheilus lucius*	E	May affect-not likely to adversely affect
Razorback sucker	*Xyrauchen texanus*	E	May affect-not likely to adversely affect
Colorado pikeminnow critical habitat	—		May affect-not likely to adversely affect
Bald eagle	*Haliaeetus leucocephalus*	T	May affect-not likely to adversely affect
Mountain plover	*Charadrius montanus*	PT	May affect-not likely to adversely affect
Mexican spotted owl	*Strix occidentalis lucida*	T	May affect-not likely to adversely affect
Mexican spotted owl critical habitat	—		May affect-not likely to adversely affect
Southwestern willow flycatcher	*Empidonax trailii extimus*	E	May affect-not likely to adversely affect

Notes: (a) E = Endangered, T = Threatened, PT = Proposed Threatened.

A BE that addressed three grazing allotments containing Mexican spotted owl critical habitat was submitted to the USFWS in 2001 (BLM 2001a). It assessed the potential effects of the BLM grazing program and determined that this program may affect, but is not likely to adversely affect, Mexican spotted owl critical habitat, to which the USFWS agreed (Cons. #22-22-02-I-240).

EFFECTS DETERMINATION RATIONALE

Knowlton's Cactus

Implementation of the Preferred Alternative may affect, but is not likely to adversely affect, Knowlton's cactus for the following reasons:

- Mineral development and OHV activities are not allowed within the fenced population on FFO land.
- Preconstruction surveys are required in all potential Knowlton's cactus habitat prior to construction.
- No oil and gas well pads and roads would be allowed in potential Knowlton's cactus habitat.
- Pipeline ROWs would be allowed contingent on conducting extensive biological surveys and adhering to stringent rehabilitation requirements.
- Monitoring surveys will continue to provide natural resource personnel with the necessary information to manage and protect FFO and USBR natural and transplant populations.

Mesa Verde Cactus

Implementation of the Preferred Alternative may affect, but is not likely to adversely affect, the Mesa Verde cactus for the following reasons:

- Oil and gas development in potential Mesa Verde cactus habitat cannot proceed without preconstruction surveys. BLM protects Mesa Verde cactus and potential habitat from development. If a project was proposed that would impact the Mesa Verde cactus and could not be relocated, consultation with the Service would be initiated.
- OHV traffic would be allowed only on graded and maintained roads in The Hogback ACEC. Measures have been taken to protect the Mesa Verde cactus from unauthorized OHV activity, such as placement of signs, closing roads, and public education.
- Coal mining would not be allowed in known or potential Mesa Verde cactus habitat consistent with Unsuitability Criterion 9.

Monitoring surveys of the Mesa Verde cactus populations will continue. This will provide BLM natural resource personnel the necessary information to manage this species.

Mancos Milkvetch

Implementation of the Preferred Alternative may affect, but is not likely to adversely affect, the Mancos milkvetch for the following reasons:

- Proposed oil and gas development in the area of potential Mancos milkvetch habitat cannot proceed without preconstruction surveys. The loss of potential Mancos milkvetch habitat is not allowed.
- OHV traffic would be allowed only on graded and maintained roads in The Hogback ACEC. This measure, and other measures specified above, have been taken to protect The Hogback ACEC from unauthorized OHV activity.
- Coal mining would not be allowed in known or potential Mancos milkvetch habitat, consistent with Unsuitability Criterion 9.

Monitoring surveys of the Mancos milkvetch populations will continue to provide natural resource personnel the necessary information to manage this species.

Colorado Pikeminnow

Based on the analysis of potential impacts from FFO programs under the Preferred Alternative assessed in this BA, the BLM has determined that these programs may affect, but are not likely to adversely affect, the Colorado pikeminnow or its critical habitat for the following reasons:

- The conclusion of a study regarding PAHs generated by oil and gas development and operations activities is that PAHs are not entering the San Juan River or its tributaries via groundwater or surface water flows.
- The use of water for oil and gas development and any other federally permitted project that would require the purchase of water would be limited to water acquired under an established legal water rights permit.
- OHV use would not occur in the River Tracts; all vehicles would be restricted to graded and maintained roads. Therefore, there would be no degradation of Colorado pikeminnow habitat due to OHV use in these areas.
- Coal mining would not be permitted in riparian areas and along major waterways.

Minor water depletions from stock ponds on FFO land would not jeopardize the continued existence of the Colorado pikeminnow or result in the adverse modification or destruction of its critical habitat because total stock pond depletions are below 100 acre-feet at any one time and the aggregate annual depletion is less than 3,000 acre-feet.

Razorback Sucker

Based on the analysis of potential impacts from FFO programs under the Preferred Alternative assessed in this BA, the BLM has determined that these programs may affect, but are not likely to adversely affect, the razorback sucker or its habitat for the following reasons:

- The conclusion of a study regarding PAHs generated by oil and gas development and operations activities are that PAHs are not entering the San Juan River or its tributaries via groundwater or surface water flows.
- The use of water for oil and gas development and any other federally permitted project that would require the purchase of water would be limited to water acquired under an established legal water rights permit.
- OHV use would be restricted to existing maintained roads, so OHV use would not result in the degradation of the razorback sucker potential habitat.
- Coal mining would not be allowed in critical habitat or riverine 100-year floodplains, consistent with Unsuitability Criteria 9 and 16.
- Minor water depletions from stock ponds on FFO land would not jeopardize the continued existence of the razorback sucker or affect its potential habitat because these depletions would be less than 100 acre-feet at any one time and the aggregate annual depletion is less than 3,000 acre-feet.

Bald Eagle

The BLM has determined that implementation of the Preferred Alternative may affect, but is not likely to adversely affect, the bald eagle because:

- No new oil and gas wells, service roads, or any habitat disturbance would be authorized in Bald Eagle ACEC core areas, and construction activities in buffer zones would be strongly discouraged. In addition, the USBR would not authorize new wells within 1,500 feet of

Navajo Dam and its appurtenant structures, within 500 feet of the maximum high water line of Navajo Reservoir, or within 500 feet of the San Juan River.

- If wells were constructed in the buffer zone of the ACEC units on BLM land, construction activity would not be allowed between November 1 and March 31.

OHV traffic would not be allowed on any trails, two-tracks, or off-road in the ACEC units. In addition, OHV traffic is not allowed in the Bald Eagle ACEC units from November 1 to March 31.

Mountain Plover

The FFO and AFO conclude that the implementation of the Preferred Alternative may affect, but is not likely adversely affect, the mountain plover for the following reasons:

- Little oil and gas development activities would take place in the potential mountain plover habitat.
- Operators proposing an oil and gas facility such as a pipeline in potential mountain plover habitat would be required to conduct preconstruction surveys if activities would take place during the mountain plover breeding season.
- Site-specific constraints would be developed if the mountain plover were found in a proposed project area, to ensure that the project would not have a negative impact on the plover.
- Projects that would create a permanent noise source that would impact nesting plovers would be subject to noise level mitigation.
- Oil and gas facilities such as pipelines would be required to be revegetated with native plant species.

In addition, the FFO concludes that other activities addressed under the Preferred Alternative may affect, but are not likely to adversely affect, the mountain plover for the following reasons:

- There are currently no plans for coal mining to take place in or near potential mountain plover habitat. If such development were proposed, the BLM would initiate the ESA consultation process.

OHV use of potential mountain plover habitat would be limited under the Preferred Alternative.

Mexican Spotted Owl

The BLM concludes that the Preferred Alternative may affect, but is not likely to adversely affect, the Mexican spotted owl or its critical habitat on FFO land for the following reasons:

- The cutting down of large ponderosa pine and Douglas fir would not be allowed, thus protecting the primary Mexican spotted owl potential habitat.
- Mexican spotted owl nocturnal surveys would be required if construction activities would occur within one-half mile of potential habitat during the breeding season. These surveys can take place for 1 year if they occur within 3 years after the completion of the formal protocol surveys. If more than 3 years have passed since completion of the formal protocol surveys, the developer would be required to conduct 2 years of surveys following the USFS protocol.
- If the Mexican spotted owl has occupied a territory in the area, no drilling or other human activity would take place within a buffer zone of one-quarter mile around the nest site during the breeding season.

- No oil and gas development would be allowed in the mixed conifer forest that is the primary potential habitat of this species.
- Coal leasing and development activities would be very unlikely in or near the Mexican spotted owl critical habitat or other marginally potential Mexican spotted owl habitats. If coal leasing and development were proposed in these areas, the NEPA process would be followed and a consultation with USFWS would be initiated.
- OHV activity would be restricted to graded and maintained roads under the Preferred Alternative in all potential Mexican spotted owl habitat.
- A Mexican spotted owl critical habitat ACEC would be implemented under the Preferred Alternative.
- No Mexican spotted owl nesting has been documented on BLM lands, and no PACs have been established on BLM lands.

Southwestern Willow Flycatcher

The BLM has determined that the Preferred Alternative may affect, but is not likely to adversely affect, the southwestern willow flycatcher on FFO and AFO land for the following reasons:

- All oil and gas development projects such as wells, roads, and pipelines are discouraged in potential habitat. Since the listing of the southwestern willow flycatcher, no projects that impact designated potential habitat have been authorized. Proposed projects have been moved or rerouted to avoid habitat impacts. In the future, if a proposed project could not be moved or rerouted, the appropriate NEPA document would be prepared and consultation with the USFWS would be initiated.
- The FFO has completed the Southwestern Willow Flycatcher Habitat Management Plan (BLM 1988) and the Riparian and Aquatic Habitat Management Plan (BLM 2000c) to provide protection for all designated riparian habitats, including all of the designated potential southwestern willow flycatcher habitat. Cadastral land surveys have been conducted and fences have been constructed on the River Tracts.
- The FFO will retain all lands that support potential southwestern willow flycatcher habitat. The AFO has placed a high priority on the restoration and protection of riparian areas under its jurisdiction, including the potential southwestern willow flycatcher habitat on AFO within the project boundary.
- Coal leasing and development in potential southwestern willow flycatcher habitat is unlikely and would not be allowed, consistent with Unsuitability Criteria #9, to protect habitat of essential value for T&E species.
- OHV use is restricted to graded and maintained roads in and in the area of potential southwestern willow flycatcher habitat.